CARIAA
Collaborative Adaptation Research Initiative in Africa and Asia

ASSAR
Adaptation at Scale in Semi-Arid Regions

Identifying Climate Risks and Assessing Differential Vulnerability of Communities in Ahmednagar and Aurangabad Districts of Maharashtra

CARIAA-ASSAR Working Paper #4

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About CARIAA Working Papers

This series is based on work funded by Canada's International Development Research Centre (IDRC) and the UK's Department for International Development (DFID) through the **Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA)**. CARIAA aims to build the resilience of vulnerable populations and their livelihoods in three climate change hot spots in Africa and Asia. The program supports collaborative research to inform adaptation policy and practice.

Titles in this series are intended to share initial findings and lessons from research and background studies commissioned by the program. Papers are intended to foster exchange and dialogue within science and policy circles concerned with climate change adaptation in vulnerability hotspots. As an interim output of the CARIAA program, they have not undergone an external review process. Opinions stated are those of the author(s) and do not necessarily reflect the policies or opinions of IDRC, DFID, or partners. Feedback is welcomed as a means to strengthen these works: some may later be revised for peer-reviewed publication.

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Abstract

India has large drought-prone drylands that support climate sensitive livelihoods for local communities. Climate variability manifested as unseasonal and low rainfall have caused heavy crop loss for farmers. Aggravating this are: non-climatic risks like market price fluctuations; decreasing land holding sizes due to fragmentation of households; and the high dependence of farmers on loans to meet the increasing input cost of agriculture.

This study presents an example of how agricultural practices in rural Maharashtra have been transformed, and are still being transformed, in response to the changing climate and to deal with the additional stresses brought on by non-climatic factors. This understanding is needed to bring research into use, to help design policies for adaptation and mitigation, while also designing projects that aim to build the adaptive capacities of the people.

We used a community-engaging vulnerability assessment tool (CoDriVE-PD) to evaluate the climate risks and vulnerabilities of socially differentiated groups. CoDriVE-PD identified locale-specific parameters and provided a score for selected indicators categorized under five livelihood capitals, presented as vulnerability codes.

Though farmers were categorized on the basis of their land ownership, social differentiation of caste and community had important bearings on the type of livelihoods, their approach to agriculture, and access to resources – all of which affected their vulnerability. Across all farmer categories, caste and social standing play a major role in access to resources. While some groups are "better off and more resilient", their resource intensive practices are environmentally harmful and adversely affect others dependent on the same resources. However, being greater risk takers, when these same groups adopt improved adaptive technologies and practices successfully, they serve as "lighthouses", inspiring others to do the same.

Vulnerability assessments need to be conducted at smaller scales rather than for districts as a whole, as climate risks vary within the clusters. There is a need to adopt a mixed methodological approach that integrates community engagement into analytical/academic research to develop appropriate adaptation policies.

About ASSAR

All authors of this working paper are team members in the ASSAR (Adaptation at Scale in Semi-Arid Regions) project, one of four hotspot research projects in CARIAA. The international and interdisciplinary ASSAR team comprises a mix of research and practitioner organisations, and includes groups with global reach as well as those deeply embedded in their communities. The ASSAR consortium is a partnership between five lead managing institutions - the University of Cape Town (South Africa), the University of East Anglia (United Kingdom), START (United States of America), Oxfam GB (United Kingdom) and the Indian Institute for Human Settlements (India) – and 12 partners – the University of Botswana, University of Namibia, Desert Research Foundation of Namibia, Reos Partners, the Red Cross/Crescent Climate Centre, University of Ghana, ICRISAT, University of Nairobi, University of Addis Ababa, Watershed Organisation Trust, Indian Institute for Tropical Meteorology, and the Ashoka Trust for Ecology and the Environment.

Working in seven countries in semi-arid regions, ASSAR seeks to understand the factors that have prevented climate change adaptation from being more widespread and successful. At the same time, ASSAR is investigating the processes – particularly in governance – that can facilitate a shift from ad-hoc adaptation to large-scale adaptation. ASSAR is especially interested in understanding people's vulnerability, both in relation to climatic impacts that are becoming more severe, and to general development challenges. Through participatory work from 2014-2018, ASSAR aims to meet the needs of government and practitioner stakeholders, to help shape more effective policy frameworks, and to develop more lasting adaptation responses.

Why focus on semi-arid regions?

Semi-arid regions (SARs) are highly dynamic systems that experience extreme climates, adverse environmental change, and a relative paucity of natural resources. People here are further marginalised by high levels of poverty, inequality and rapidly changing socio-economic, governance and development contexts. Climate change intersects with these existing structural vulnerabilities and can potentially accentuate or shift the balance between winners and losers. Although many people in these regions already display remarkable resilience, these multiple and often interlocking pressures are expected to amplify in the coming decades. Therefore, it is essential to understand what facilitates the empowerment of people, local organisations and governments to adapt to climate change in a way that minimises vulnerability and promotes long-term resilience.

www.assaradapt.org

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Contents

List of Abbreviations

CoDriVE-PD	Community Driven Vulnerability Evaluation - Programme Designer
CPR	Common Property Resource
FC	Forward Caste
FGD	Focus Group Discussion
GIS	Geographic Information System
NABARD	National Bank for Agriculture and Rural Development
NGO	Non-Governmental Organization
NTFP	Non-Timber Forest Produce
OBC	Other Backward Class
PDS	Public Distribution System
SARs	Semiarid regions
SHG	Self Help Group
ST	Scheduled Tribe
VJNT	Vimukt Jati Nomadic Tribes

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1. Setting the Context

Drylands, which include arid and semi-arid regions (SARs) – of which 90% are in developing countries – cover about 40% of Earth's land surface and are inhabited by more than two billion people. Among dryland subtypes, ecosystems and populations of SARs are the most vulnerable to loss of ecosystem services (Safriel et al, 2005). Livelihood sustainability in these regions is exposed to a range of multifaceted and interconnected social, economic, political, and environmental changes that present significant challenges to researchers, policy makers, and mainly the rural poor. It is necessary to understand the dynamic relationship between socio-ecological systems and developmental strategies to help strengthen the resilience of people's livelihoods, particularly at this time of growing uncertainties around climate and non-climate variability (Fraser et al, 2011).

India is one of the most drought-prone regions of the world; about 69% of its geographical area falls under dryland (arid, semi-arid and dry sub humid) and receives less than 750mm of rainfall (MOEF, 2010). These areas are highly populated and the livelihoods of the people depend on rainfed farming. These regions experience year to year fluctuations in agricultural production and, therefore, in incomes. High dependence on climate sensitive sectors and the poor socio-economic and low bio-physical status of the habitat makes the rural poor the most vulnerable to climate change.

Drylands suffer from low and erratic rainfall, frequent drought, high evaporation, intense heat and high winds. The soils are not conducive to intensive cropping. The density of both human and livestock populations is high as compared to the national average (MOEF, 2010). About a quarter of India's drought-prone districts are in Maharashtra, which has 73% of its geographic area classified as semiarid and about 84% of the total area under rainfed agriculture. Trends indicate that the state could face an increase in rainfall variability, including drought and dry spells, making agriculture particularly vulnerable to climate change (TERI, 2014).

Owing to their low biophysical, social and technological status, the states of Maharashtra, Madhya Pradesh, Karnataka, Andhra Pradesh, Bihar and Rajasthan have low adaptive capacity, hence are more vulnerable to climate change. However, even within a region experiencing similar characteristics of climate change, the impacts are likely to vary because some ecosystems, sectors and/or social groups are more vulnerable than others (O' Brien et al, 2004). The impacts of climate change are transformed into differentiated outcomes through socio-economic structures defined by social or political identities, age, gender, accessibility to resources and infrastructure and others (Ribot, 2010). Even within regions where incomes and adaptive capacities are relatively high, certain groups of people can be particularly vulnerable; these are women, children, and the elderly. Formal and informal systems and institutions in India shape the capabilities for men and women and of people belonging to various communities differently. For example, the stratified caste system influences the individual's rights to access to resources; people from scheduled castes form 'the weakest economic segment of rural society with limited access to education and financial institutions, and little effective voice' (Simmons and Supri, 1997)

The discourse on climate change has witnessed a shift in understanding the phenomenon from a gender neutral perspective to one that currently seeks to understand gendered vulnerability. Limited access to resources, patriarchal patterns and a lack of decision-making power contribute to women's vulnerability to climate change. The social structure that defines the roles and responsibilities of

women, where they are directly dependent on natural resources such as fetching water and fuel, make women disproportionately vulnerable to the effects of climate change (Mearns & Norton, 2010). The impacts of climate change may prove particularly severe for women. Impacts such as increasing scarcity of water, reduction in yields of forest biomass, and increased risks to human health; children, women and the elderly becoming the most vulnerable. With the possibility of decline in the availability of food grains, the threat of malnutrition may also increase. All these would add to deprivations that women already encounter and so in programmes, special attention should be paid to the gender aspects (GoI, 2008).

Vulnerability assessment tools may be used at multiple scales when adaptive planning is needed to reduce climate and non- climate stresses. To design feasible and sustainable interventions that emerge from vulnerability assessment recommendations, the analysis must consider local people's needs and aspirations and their socio-economic contexts (Ribot, 2010). The concept of differential vulnerability across social groups including gender, in line with human wellbeing, also needs to be incorporated in adaptation and developmental planning. When vulnerability is viewed from a multi-dimensional perspective, it will help to recognize, arrange, plan and channel the resources to improve the capacity to adapt more effectively (Singh et al, 2014).

This study attempts to understand vulnerability to climate change in the context of social differentiation including gender, in selected villages in two districts in Maharashtra state. The research objectives of the study are to:

1. Understand the risks faced by different categories of people within a village and identify the most vulnerable groups.

2. Examine the past and current strategies employed by the respective groups to manage risks.

3. Identify the enablers and barriers influencing decision making/ strategies of the various social groups, as they cope with the existing climate risks.

2. Methodology

2.1 Application of community based vulnerability assessment tool

The methodology for assessing vulnerability of a representative village is done using the CoDriVE-PD tool. This is a participatory tool developed by Watershed Organization Trust (WOTR) for assessing vulnerabilities of communities, villages and landscapes to climatic and non-climatic risks, with a view to responding with locale-specific adaptation plans. The application of the CoDriVE-PD tool has four methodological steps:

- *Step 1* builds a vulnerability context to understand changes in environment and causes. This step generates information on how livelihoods are changing and identifies the drivers and pressures that trigger the change. It also identifies the indicators affecting the adaptive capacities of the community.

- *Step 2* maps climate risks, impacts and responses. This involves engaging communities to identify and map the major climate risks, their impacts and how they respond to the risks the region has been experiencing during the past decade. The step also involves a contextual understanding of the communities' coping and/or adaptation responses to climatic variability and risks. It helps to identify the responses that reduce or enhance the vulnerabilities of the natural resource base and of the community to long term climatic variations.

- *Step 3* assesses the various indicators that demonstrate the vulnerability of the community. This step involves perception-based scoring of the indicators under five livelihood capitals on a scale of 1 to 5 for all the social categories. The scores are then validated using information from the baseline survey, census data and other secondary sources. The vulnerability scores are as follows:

Vulnerability context	Score
Very high vulnerability	1
High vulnerability	2
Medium vulnerability	3
Low vulnerability	4
Very low vulnerability	5

- Finally, *Step 4* generates the vulnerability code. The indicators obtained from *Step 3* are grouped into five livelihood capitals. These are: the physical capital (e.g. infrastructure, facilities), financial capital (e.g. incomes, access to credit, subsidies), natural capital (e.g. land, livestock, forest, water), human capital (e.g. access to knowledge inclusive of traditional, skills) and social capital (e.g. institutions, groups and networks). The final scores are derived using the simple average of the scores obtained by the indicators listed in a particular capital.

BOX 1

About the tool- Community Driven Vulnerability Evaluation-Program designer (CoDriVE-PD)

The framework of the tool CoDriVE-PD is based on: (1) Driver-Pressure-State-Impact-Response (DPSIR; EEA, 2007); (2) the UK Department for International Development's Sustainable Livelihoods Framework (DfID, 1999); and (3) the IISD's Community Risk Screening Tool: adaptation & livelihoods – CRiSTAL (IISD, 2012).

CoDriVE-PD helps to make a quick but precise assessment of the climate risks and vulnerabilities of an area through community engagement. It helps build a vulnerability context; identifies climate risks and trends; and builds an adaptation response/coping mechanism inventory that aids evaluation and tracking. It provides a five digit multi-dimensional 'vulnerability code' based on the five livelihood capitals (financial, human, natural, physical and social) and is backed by a list of locale-specific resilience indications. CoDriVE-PD has an emphasis on identifying locale-specific indications, thus reducing risks that arise from using broad or pre-determined indices, which may prove inappropriate in local contexts.

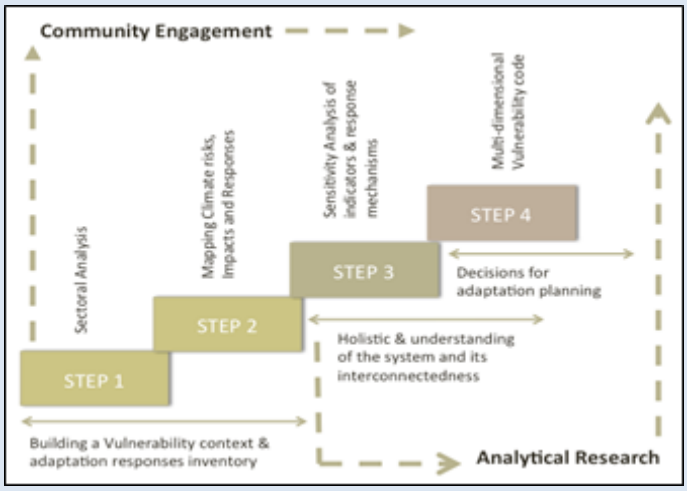

Figure 1: Analytical Framework of CoDriVE-PD

CoDriVE-PD uses the systems thinking approach for managing the knowledge/information it generates. 'Systems thinking' is a conceptual framework for problem-solving, which considers issues in their entirety. It involves pattern finding, to enhance the understanding of and responsiveness to the problem/issue at hand (Rubenstein-montano et al, 2001). Systems thinking is widely applied in different scientific disciplines and is a potent approach to understanding the system in reality. It is based on the assumption that an analysis of all individual elements of a system, as well as their inter-linkages and relationships, need to be taken into account for a holistic understanding of a system (Schiuma et al. 2012).

2.3 About the area

This study is located in the Sangamner *taluka*[1] of Ahmednagar district and Aurangabad, and Paithan *talukas* of Aurangabad district, Maharashtra, India. The study areas selected are sites where development work was implemented by an NGO. In Sangamner, we studied a cluster of 17 villages covering a contiguous area of 14,604 ha, inhabited by approximately 3,138 households. The Sangamner *taluka* lies in the rain-shadow belt of Maharashtra. It consists of an irrigated portion and a plateau region. The latter is rainfed, semi-arid and drought prone and is the location of the study site. The average annual rainfall is this region is 560.7 mm. In Aurangabad district, a cluster of 10 villages covering an area of 5,252 ha having 920 households was selected. These are in the Aurangabad and Paithan *talukas.* Though administratively these are two *talukas*, the villages are actually contiguous and have similar conditions. The average annual rainfall in Aurangabad is 725.8 mm.

2.4 Typologies within the study sites

When assessing the vulnerabilities within a landscape, bio-physical differences exist between villages, despite them being contiguous. These include location of villages within the catchment, topography (slope), soil erosion status, natural vegetation cover, wastelands, water-body spread area, groundwater status and accessibility to markets. These distinctions indicate variations in the vulnerabilities of the resource base and its people in general, which are further exacerbated due to the climate risks in the area. Once the typologies are identified, representative villages are randomly selected for assessing their vulnerabilities.

Typology mapping resulted in the identification of two typologies each in the Sangamner and the Aurangabad-Paithan clusters respectively (Figure 2 and Figure 3). The typologies differ in terms of location in the catchment, vegetation cover, groundwater status and accessibility to markets (Table 1). In the Sangamner cluster, 11 villages fall in Typology 1 (upper catchment of Mula river) and six in Typology 2 (middle and lower catchments of Mula river); while in the Aurangabad-Paitan cluster, all the villages are located in the upper catchment of Godavari river and the villages were categorized into typologies based on their access to markets. Villages in Typology 1 were farther from markets than villages in Typology 2. Three villages are located in Typology 1 and seven in Typology 2.

Within each typology representative villages were randomly selected for applying CoDrive-PD.

[1] A *taluka* is an administrative division demarcated by the state revenue department at sub-district level.

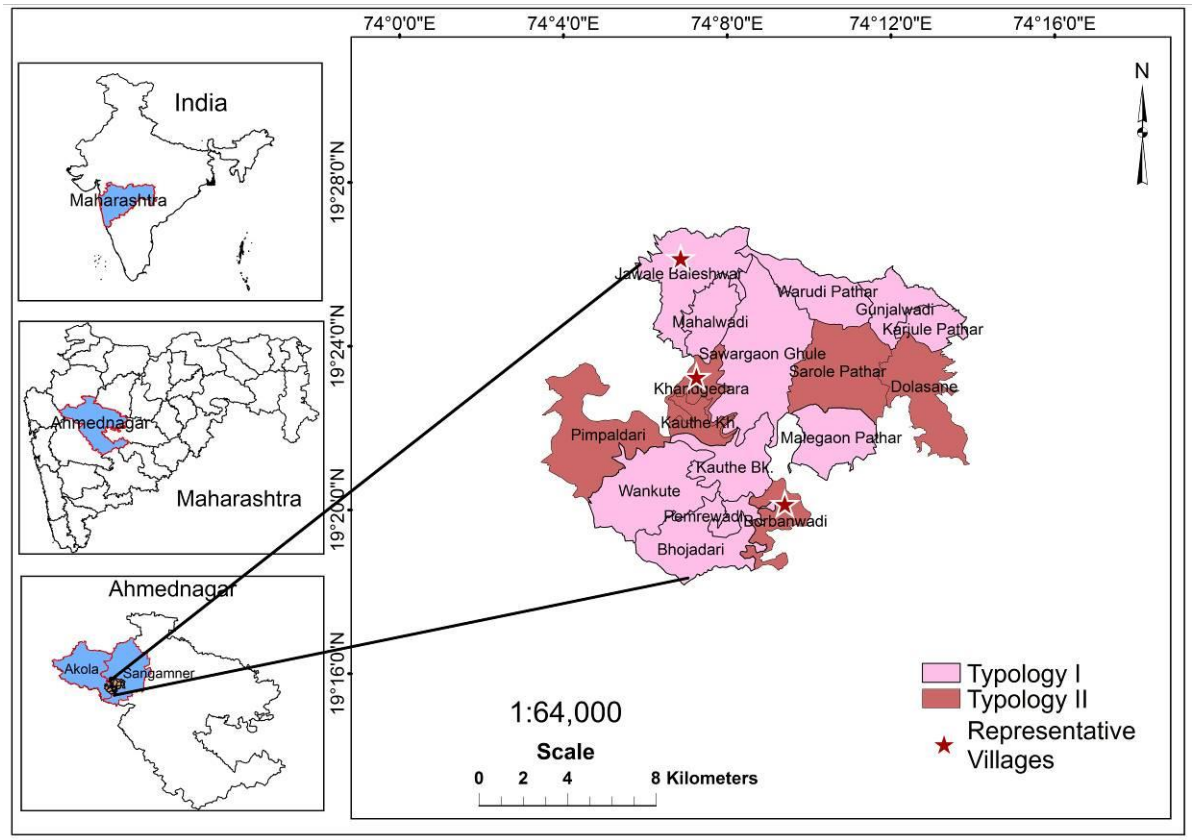

Figure 3: Typology map of Sangamner Cluster, Ahmednagar district

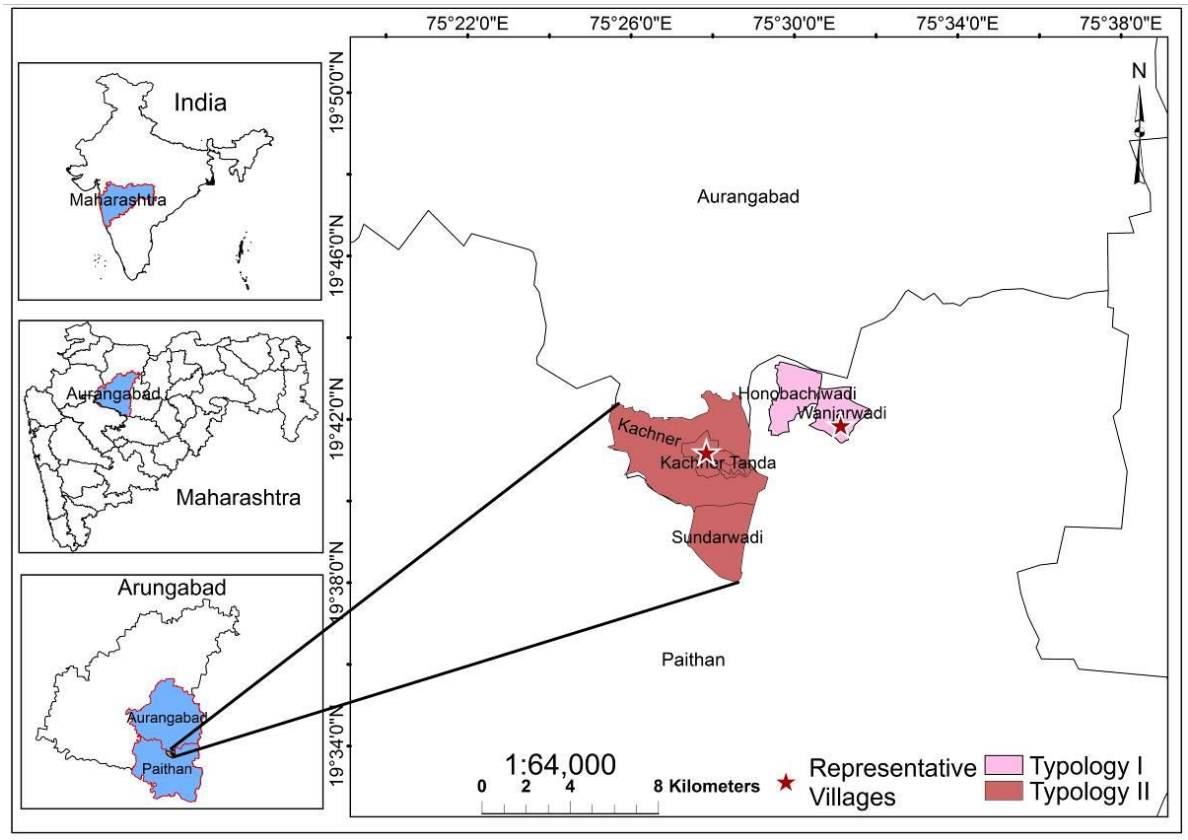

Figure 2: Typology map of the cluster of villages in Aurangabad and Paithan *talukas*, Aurangabad district

2.5 About the selected villages

The following section describes the characteristics of the representative villages of each typology that have been selected for applying the CoDrive-PD tool (Table 1). The representative villages selected in the Sangamner *taluka* – *Jawale Baleshwar* (Typology 1)*, Khandgedara and Borban* (Typology 2) – are located in the upper, middle and lower catchments of river Mula respectively. The nearest market place for these villages is *Ghargaon*. *Borban* is nearest to the market centre (3-4 km away) and *Jawale Baleshwar* farthest (about 32 km away). The subsurface geology of *Jawale Baleshwar* and *Kandgedara* villages consists of hard massive basalt lava flow forming an undulating landscape. This limits deepening of existing wells and digging of new wells. It escalates the cost of such activities and is beyond the reach of small and marginal farmers. In terms of social categories, in the Sangamner area, *Borban* village is dominated by Other Backward Class (OBC) category (namely, *Mali*). In *Khandgedara*, the population mainly comprises of the Forward Caste (FC) category (*Maratha*) with a small percentage of Scheduled Tribe (ST) category (*Mahadev Koli*). The population of *Jawale Baleshwar* comprises of FC (*Maratha*) and Scheduled Castes (SC; *Mahadev Koli*) in almost equal proportion.

The representative villages selected in the Aurangabad cluster are *Kachner Tanda 1 & 3* which are in the Aurangabad *taluka* (Typology 1) and *Wanjarwadi* of *Paithan taluka* (Typology 2). With regard to the social groups, *Kachner Tanda 1 & 3* have a homogenous population belonging to the *Vimukti Jati Nomadic Tribes* (VJNT) category (*Banjara*). In *Wanjarwadi* the majority of the households belong to the Forward Caste category (*Rajput*). The nearest market to this cluster is *Adul*, with *Wanjarwadi* being the nearest village to the market (4.1 km).

Table 1: Characteristics of the representative villages

Typology	Block & Village	Characteristics	Population (percent)
Typology 1: Upper catchment of Mula River	Sangamner: *Jawale Baleshwar*	Over exploited groundwater resources Slight soil erosion Relatively far from market centre	1027 (FC- 52%; ST- 47%) Landless: 1%, Small and Marginal: 70%, Medium and Large: 29%
Typology 2: Lower catchment area of Mula river	Sangamner: *Borban*	Over exploited groundwater resources[2] Severe soil erosion Near market centre (*Ghargaon*)	812 (OBC- 85%; ST- 15%) Landless: 0% Small and Marginal: 100% Medium and Large: 0%
Typology 2: Middle catchment of Mula river	Sangamner: *Khandgedara*	Groundwater status safe Moderate soil erosion Relatively far from market centre	301 (FC- 70%; ST- 30%) Landless: 9% Small and Marginal: 41% Medium and Large: 50%
Typology 1: Upper catchment area of the Godavari	Aurangabad *Kachner Tanda* 1	Groundwater status is safe Far from market centre (*Adul* at a distance of 13km)	268 (VJNT -100%) Landless: 4% Small and Marginal: 68% Medium and Large: 28%
Typology 1: Upper catchment area of the Godavari	Aurangabad *Kachner Tanda* 3	Groundwater status is safe Far from market centre (*Adul* at a distance of 16.5km)	177 (VJNT - 100%) Landless: 21% Small and Marginal: 55% Medium and Large: 24%
Typology 2: Upper catchment area of the Godavari	Paithan *Wanjarwadi*	Ground water status is safe Accessibility to market (4.1km)	271 (FC- 89%) Landless: 4% Small and Marginal: 53% Medium and Large: 44%

Composition of caste categories in the area: FC=*Marathas*, *Rajputs*; OBC = *Mali*; VJNT= *Banjaras*; ST=*Mahadev Kolis*

[2] According to the data obtained from the Groundwater Surveys Development Agency, the status of the groundwater has been identified as overexploited for *Borban* and *Jawale Baleshwar* (i.e. the extraction rate exceeds the recharge rate by more than 100%) while for *Khandgedara* it is safe (i.e. extraction rate is 50-70% of the recharge rate).

2.6 Data collection process

A total of 23 focus group discussions (FGD) were conducted with farmers belonging to different landowning and social categories, as well as women in the representative villages. The FGDs were conducted between September 2015 and February 2016 (Table 2). The information gathered was triangulated with secondary information obtained from baseline data and other data available from the local line department officials.

The farmers were categorized based on land ownership. The categories included large farmers (>4ha), medium farmers (2 to 4ha) and small and marginal farmers (<2ha). Apart from the farmer categories, the landless and women were considered as separate categories. The information gathered through CoDriVE-PD included current and past data, sector-wide drivers and pressures of change, trends in temporal climate risk mapping and their impacts on communities, and an inventory of adaption responses/coping mechanisms in the context of crop production, livestock production and other non-farm based livelihoods. Climatic and non-climatic risks, their effects and the responses of the communities as they cope with these risks, were also noted.

Table 2: Number of focus group discussions with different categories of farmers

Categories of farmers	No. of FGDs	Villages
Large farmers	2	*Jawale Baleshwar*, *Kandgedara*
Medium farmers	4	*Wanjarwadi*, *Kachner Tanda* 1 and *Kachner Tanda* 3
Small and marginal farmers	6	*Wanjarwadi*, *Kachner Tanda* 1 and *Kachner Tanda*, *Jawale Baleshwar*, Kandgedara, *Borban*
Landless	3	Kandgedara, *Jawale Baleshwar*
Women	8	All 6 villages
Total number of FGDs	23	

3. Results and discussion

3.1 Profile of the social groups

Though the farmers are categorized mainly on the basis of their land ownership, social differentiation on the basis of caste communities is also considered, as it has important bearings on the type of livelihoods taken by different groups. The caste categories present in the study areas are the FC, OBC, SC and ST. Historically, landownership was closely associated with the social categories (caste), where higher caste groups (FC) had large landholdings as compared to lower caste groups (SC or ST). In the study areas, the large and medium farmers mainly belong to the FC (*Maratha*, *Rajput*) and a small percent are of the *Vimukta Jati* and *Nomadic Tribes* (VJNT) category (*Banjara*). Farmers belonging to small and medium landholding categories include all caste groups, namely: ST (*Mahadev Koli*), OBC (*Mali*), FC (*Rajput*) and VJNT (*Banjara*). However, division of households and land through generations has resulted in small and fragmented land holdings. Hence many large- and medium-farmers are now categorized under small and marginal land-owner categories. The villages studied have a very high population of farmers belonging to small and marginal land-holding categories (ref to Table 1).

In both the regions, farmers belonging to large and medium land-holding categories practice water-intensive crop cultivation (horticulture and commercial crops) and dairy production. On the other hand, the small and marginal farmers (except the *Mali*, due to lack of irrigation facilities), practice subsistence farming, rear small ruminants, and depend mainly on wage labour work for sustenance (Table 3).

Table 3: Characteristics of the different farmer categories

Farmer category	Social category	Agriculture			Livestock			Wage labour
		Cultivation (Two seasons)	Cultivation (One season)	Own Irrigation Sources	Large -(Bullock)	Large -(Dairy Animals)	Small (Goats)	
Large	FC (*Maratha*)	X		X		X		
Medium	FC(*Maratha*)	X		X	X	X		
	FC (*Rajput*)	X		X			X	X (skilled)
	VJNT (*Banjara*)	X		X	X		X	X
Small and Marginal	OBC (*Mali*)	X		X	X			
	ST (*Mahadev Koli*)		X				X	X
	FC (*Rajput*)		X				X	X
	VJNT (*Banjara*)		X		X		X	X
Landless	ST (*Mahadev Koli*)						X	X

In Sangamner, the FC (*Maratha*), OBC (*Mali*), and ST (*Mahadev Koli*) are the major social groups. In the past (20-30 years earlier) farming practices and patterns were similar for all the farmer categories irrespective of the castes to which they belonged. Agriculture was completely rainfed with subsistence crops grown. However, over the last couple of decades there has been a significant change in the farming system. Agricultural practices among large and medium farmers have become resource intensive with shifts according to crop preferences (horticulture and commercial crops) and dairy production with crossbreeds. The OBC (*Mali*), who – owing to their small land holdings – have been categorized here as small and medium farmers, stand out distinctly as they have been cultivating pomegranate as a large-scale mono-crop. Livestock ownership among them is negligible. The ST communities (*Mahadev Koli*) too were agriculturists with large landholdings in the past. But over the years they have become marginal farmers or landless, with the majority of them depending on wage labor for their livelihood. They prefer to rear goats over cattle as a livelihood option.

In Aurangabad, the predominant social groups are the VJNT (*Banjara)* and FC (*Rajput*). The *VJNT* (*Banjara*) were earlier nomadic, but over three decades, they have settled into agriculture and allied activities. Being a nomadic pastoral tribe, they reared large herds of cattle and goats in the past. They possess good traditional knowledge on animal husbandry. The FC (*Rajput*) community in Aurangabad on the other hand is similar to the *Maratha* of Sangamner in terms of farming (focus on cash crops) as well as social status. Bt cotton is currently the most popular commercial crop grown by all farmer groups of Aurangabad in the Marathwada region of Maharashtra, which is an important cotton-producing belt. While the medium farmers cultivate cotton, the small and marginal farmers, particularly the VJNT (*Banjara*) now practice rainfed agriculture, growing mostly food-cum-fodder crops. Livestock holding among all farmers groups, except the *Banjara,* has reduced significantly due to declining water resources.

3.2. Climate risks to livelihoods, the impacts and current responses of communities in the study sites

This section summarizes the climate events as perceived by community members during the focus group discussions (Table 4). The impacts of the observed climate risks and the current responses to these are detailed for agriculture, livestock production, livelihood and general quality of life and human health. Coping mechanisms varied among the different social categories indicating their adaptive capacity and vulnerability in relation to the five livelihood capitals (*See* Section 3.5).

Precipitation

The people in both study regions have noted rainfall variability as unseasonal rainfall, reduced seasonal rainfall and fewer rainy days in the monsoon, prolonged dry spells and high intensity rainfall. The specific impacts related to rainfall are as follows:

- *Unseasonal rainfall*: Since 2008, the rainfall has been erratic with frequent heavy downpours at night (Aurangabad). The increased humidity has affected standing crops as well as stored grain. Morbidity of livestock has increased affecting their growth and metabolism. In the context of human health, an increase in vector-borne diseases has been reported, including

health problems caused by consumption of spoiled grain and contaminated stored drinking water.

- *Reduced monsoon rainfall and increased dry spells:* Since 2008, the total precipitation has been decreasing in both regions, particularly in the number of rainy days during the monsoon. Decreasing precipitation in both regions was stated to cause drying of the vegetation on common and private lands. Reduced water availability in wells (for about 9 months a year or less) and crop production losses were the main impacts reported. Scarcity of drinking water for humans and livestock and food insecurity increased. However, in village *Borban*, the production losses have seldom been experienced because pomegranate can withstand high temperatures provided irrigation facilities are available.

- *Delayed onset of monsoons:* Both regions have observed delayed onset of monsoons over the past 8 years, which at times arrived in late August or even in early September. The impacts experienced by the communities were drops in crop yields due to late sowing and the lack of access to seed material of short duration crops (a contingent measure). Poor viability of hybrid seeds has also been reported, therefore farmers have had to invest in purchasing more seeds than normally required. However, the latter two are non-climatic causes that aggravate the climatic risks farmers face.

- *High intensity rainfall:* This has been reported in the early winter (November) every year over the past few years (except in the year 2014). The heavy rainfall caused damage to crops, water harvesting structures and *kaccha*[3] houses.

Temperature

- *Warmer winters/reducing number of cold days in winter:* Communities shared that the winters have not been as cold as in the past, particularly over the past 8 years. Four months of cold season have now reduced to barely one month. The year 2014-15 witnessed almost no winter with daytime temperatures reaching 30°C to 32°C in the month of January, particularly in Aurangabad. Communities reported that all crops (wheat, coarse cereals, pomegranate, cotton, onion) are affected in one way or another leading to production decline. As stated by the people, in 2014 practically no wheat was produced, as winter did not even exist. What has been observed for the first time is that the otherwise robust sorghum and pearl millet have had reduced productivity. The warmer winters affected the flowering of pomegranate and quality of the onion crop. However, as these crops are cultivated mainly by the large and medium farmers who have better access to agricultural inputs (pesticides and other chemical measures), the loss experienced by them was relatively low.

- *Increasing summer temperature* is another important climate risk reported by communities since 2011. Excessive heat has been observed to affect agriculture production at various growth stages, vegetation cover, livestock, water scarcity and livelihoods in general. Heat stress was more explicit in Aurangabad as compared to Sangamner and more among the small and marginal farming category, children and the elderly. Increase in indoor temperatures was also stated. While many houses are now constructed of cement, the roof is

[3] *Kaccha* houses are made up of mud or hay stacks or tin roof.

generally of metal/tin sheets, which greatly increases daytime indoor temperature in other seasons.

In relation to the above climate risks, a few general issues were cited by communities that affected their quality of life:

- Limited work opportunities for men triggered gambling and /or consumption of alcohol.
- Increasing debts were stated by some households as disrupting their happiness, particularly when the emphasis was on commercial crop cultivation.
- As the public distribution system (PDS) partially meets their needs, crop loss and lowered income increased their expenditure on food, thus adding to their financial burden.
- Prolonged general weakness resulted in the inability to work in the fields for long hours, which further aggravated the loss of income and created the vicious circle of vulnerability.

Table 4 presents the impacts of the climate risks mentioned above and how farmers responded to or coped with these risks.

Table 4: Climate risks and impacts as perceived by the communities and their responses

Climatic Risks	Impacts	Responses of Communities
PRECIPITATION		

Unseasonal/ erratic rainfall	• Increased pest and disease attacks in crops
	• High investments made in pesticides impacted income and human health
	• Crop loss and low quality produce resulted in loss of income
	• Spoilage of stored grain resulted in food and seed shortages
	• Increased incidence of disease in livestock
	• High Morbidity in goats/milch animals resulted in loss of animals/income
	• Increased viral and vector borne diseases in humans; high incidence of dengue, chikungunya, flu, allergies and viral attacks in humans
	• Stored drinking water was contaminated
		• Increased purchase and use of pesticides and fertilizers
		• Sought government scheme (e.g. crop insurance, loan waiver)
		• Increased expenditure on health care for livestock:
		  ○ for dairy cattle by large and medium farmers
		  ○ for goats by small and marginal farmers
		• Depended on markets and the Public Distribution System (PDS) for food needs
		• Increased visits to hospitals/expenditure
		• Sought unskilled wage labour work

Reduced monsoon rainfall and Prolonged dry spells	• Reduced seed germination • Crop dried in early stages • Increased production costs due to re-sowing and /or re-application of fertilizers to ensure crop production resulted in reduction of soil quality	• Increased application of fertilizers • Crops re-sown (more quantity of seed used per acre) • Change in crops grown • Improved production technologies for onion production (e.g. mulching & growing on raised beds)

	❖ Drying up of the vegetation on commons resulted in fodder scarcity ❖ Water scarcity for humans and livestock ❖ Food scarcity ❖ Reduced work not available on farms (own or others)	❖ Shifted from water intensive commercial crops to short duration crop varieties and rainfed food crops (e.g. pearl millet) ❖ Sowed onion in winter season ❖ Use of drip irrigation ❖ Deepened wells ❖ Water for domestic purposes supplied in tankers (government supported) ❖ Food security depended on PDS ❖ Depended on wage labour works
Delayed onset of monsoon	❖ Crop yields reduced ❖ Germination of seed reduced due to high daytime temperatures, improper storage facilities and delayed sowing ❖ Increased input costs (double sowing) ❖ Crop yield affected due to lack of access and availability of appropriate seeds of short duration varieties. ❖ Loss of income from agriculture ❖ Fodder shortage on commons ❖ Water shortage ❖ Food insecurity	❖ Change in sowing dates ❖ Re-sowing of crops ❖ Increased investment in purchasing more seeds than required resulted in increased production costs ❖ Shift to food cum fodder crops (among small and marginal farmers) ❖ Accessed government schemes to support high value crops (horticulture crops) ❖ Water from the river (*Borban*) unsustainably extracted ❖ Depended on loans ❖ Depended on PDS for food needs ❖ Small and marginal farmers depended on alternate unskilled livelihood sources (wage work)
High Intensity Rainfall	❖ Heavy crop damage at harvest time ❖ Water stagnation in farms resulted in crop decay leading to fodder and food loss ❖ Spoilage of stored harvest (fodder and grain) ❖ Diseases in livestock increased losses due to morbidity ❖ Breakage of check-dams, flash flooding ❖ Damage to k*accha* houses ❖ Water borne diseases in humans	❖ Sale of poor quality grain and fodder (if possible) and at very low prices ❖ Purchase of food grain and depended on the PDS ❖ Required loans for repair of houses ❖ Sought unskilled wage labour (men and women of small and marginal households) ❖ Increased health care expenditure to treat water borne diseases
Reduction in total monsoon precipitation (drought)	❖ Groundwater levels dropped ❖ Water availability in wells was for 6-7 months or less a year ❖ Losses in crop production due to reduced rainfall / water for irrigation ❖ Gradual decrease in tree cover and vegetation on common lands resulted in fodder shortages ❖ Shortage of drinking water	❖ Increased Investment in deepening of wells/ digging new wells/micro irrigation (large and medium farmers) ❖ Shifted from commercial crops to food crops ❖ Experimented with different seed companies – for cotton crop only ❖ Gradually reduced the number of milch animals (*Rajput /Banjara*)

		❖ Retained bullocks to support agriculture (small and marginal) ❖ Purchased fodder from market (large and medium farmers) ❖ More focus given to goat husbandry – under partial confinement (*Banjara*) ❖ Focus given to integrating crop and livestock farming (small and marginal farmers) ❖ Agricultural lands left fallow and people temporarily migrated for wage labour (small and marginal farmers) ❖ Purchased drinking water ❖ Constructed drinking water troughs near public water connection to store water for livestock (*Banjara*)
TEMPERATURE		
Warmer winters/ reducing number of cold days in winter	❖ Reduced yields and stunted growth was found in wheat and cotton ❖ Increased pest and disease attacks in sorghum, pearl millet, onion ❖ Flowering (in winter) in pomegranate reduced (Sangamner) ❖ Loss in income due to reduced crop quality ❖ Loss of food ❖ Increased incidence of disease in goats ❖ Health problems increased, particularly in children and the elderly	❖ Reduced wheat cultivation and shift to cotton which extended into the *rabi* season (winter season) (Aurangabad villages) ❖ Increased application of fertilisers to ensure productivity ❖ Experimented with different seed companies (for cotton only) ❖ Harvested cotton early (in January instead of March) ❖ Increased the crop rotation period from one to three years in cotton ❖ Small and marginal farmers shifted from wheat to sorghum or pearl millet ❖ Depended on agents to sell low quality crops ❖ Increased investments on health care of goats; Small and marginal farmers sold morbid goats at lower prices ❖ Purchased food grains in times of shortage ❖ Alternate livelihood sources sought (e.g. small and marginal farmers depended on farm–based wage work) ❖ Increased expenses on human health care

Increasing temperature in summer	❖ Excessive heating of soil reduced crop productivity ❖ Reduction in seed viability ❖ Vegetation loss on common lands resulted in fodder scarcity ❖ Heat stress in livestock (cattle) ❖ Greatly reduced milk output (Sangamner) ❖ Water scarcity ❖ Spoilage of stored food resulted in ill health in humans and food shortage ❖ Unsuitable housing infrastructure (tin roof) further increases indoor temperatures ❖ Heat stress in humans (small and marginal farmers) [Aurangabad] resulted in reduced ability to work for regular hours	❖ Reduced number of milch animals (*Rajput/Banjara* only) ❖ Shifted to goat production – semi-intensive system followed by some communities ❖ Increased health care expenditure for humans due to heat stress

3.3. Non- climatic risks

3.3.1 Price fluctuations and the lack of post- harvest infrastructure

Market price fluctuation is a major problem which is worsened by climate risks (Section 3.2 above). The small and marginal farmers in particular (both regions) sell the produce immediately post-harvest at low prices. Perishables (tomatoes in Sangamner) are lost due to market saturation. The small quantities of cotton and food crops produced in Aurangabad are sold through middle level traders. Lack of post-harvest infrastructure exacerbates the risks.

3.3.2 Loss of common property resources

Common property resources play an important role in the economic, cultural and social activities of poor rural women and men (Beck and Nesmith, 2001). An important indicator of the reduced productivity of CPRs is the greater time and longer distances required to collect the same quantity, or lesser quantities of CPR products today as compared to the past (Jodha, 1990). Earlier, both the Sangamner and Aurangabad study areas depended heavily on CPRs for fuel wood, fodder, non-timber forest produce and medicinal plants. CPRs have reduced due to the expansion of agriculture and people's access to forests.

3.3.3 Depletion of groundwater

Groundwater in recent years has become the major source of irrigation in the area. The share of wells in net irrigated areas is very high (at 92% in 2011-12) in Sangamner (Government of Maharashtra, 2013). According to the Groundwater Survey Development Agency (GSDA), the status of groundwater in Sangamner has been as 'over exploited' (the extraction rate exceeds the recharge rate by over 100%) in *Borban* and *Jawale Baleshwar*, but in *Khandgedara* it is safe. The Aurangabad district has relatively moderate to good groundwater potential.

3.3.4 Decreasing land holding size/land fragmentation

In the Aurangabad cluster, a decrease in the size of land holdings (due to division of land within households) was found to influence cropping patterns. The currently cultivated cotton, pigeon pea, wheat and pearl millet or sorghum has affected fodder availability and the size of livestock holdings. In both study sites, a decrease in land holding size has led to a decline in crop productivity, as farmers have shifted to mono-crop cultivation with increase in crop density.

3.4. Enablers and Barriers

The transforming structures and processes within the sustainable livelihood framework, such as organizations, policies, laws and incentives shape people's livelihood options. In this section, some of the regional government and non-government programs that have influenced the five capitals of the study area are discussed. Both enablers and some of the key barriers specific to sections of the society are described.

3.4.1 Access to credit

Crop loans of the government and other specialized schemes financed by the National Bank for Agriculture and Rural Development (NABARD) through nationalized and regional banks were available and accessible to meet the short and long-term credit needs of farmers. While large and medium farmers accessed the loans, due to incidents of non-repayment by some farmers, the small and marginal farmers were generally denied loans fearing similar non-repayments. In drought-like situations, crop loan waivers were declared under political pressure by the government, which resulted in non-repayment of loans that prevented farmers from accessing new loans when needed.

In Sangamner, while formal and informal credit facilities were available for all the farmer categories, it was the large and medium farmers that accessed credit from the banks. The small and marginal farmers relied on the informal credit system (loans from large farmers, money lenders and Self Help Groups [SHGs]). Villages that had good communication (transport) infrastructure had easier access to banks and availed of the services, while those located far off, often resorted to informal credit systems.

3.4.2 Soil and water conservation measures

The soil and water conservation measures taken up as part of watershed development activities by NGOs increased the groundwater levels and its availability, reducing the impacts of drought-like situations. In the study area, the participatory processes used brought all communities and categories together wherein all farmer groups, irrespective of social category, benefitted from the program. When common wells dried up, some farmers shared water from their wells with other households. However, in many other watershed development programs, barriers existed that limited access of small and marginal farmers and the landless to the benefits accrued from the program, raising questions of equity (Shah, 2001).

3.4.3 Government subsidies for agriculture and welfare measures for SC/ST communities

Subsidies for agricultural inputs (seeds, fertilizers, irrigation equipment, and implements) were provided by both state and central governments. Farmers from all categories benefitted to a large extent from the seed and fertilizer subsidies. Various state or central government developmental programs for the welfare of the SC/ST populations have existed in the region as an additional effort to help people out of poverty, e.g. by providing agriculture inputs, micro irrigation and farm implements, and promoting non-farm livelihoods. However, only a few small and marginal farmers and SC/ST households have been able to access these subsidies due to the demanding terms, conditions and procedures.

3.4.4 Provision of drinking water and sanitation facilities

Both government and NGOs have contributed to providing piped supply of drinking water and the construction of toilets in rural households. The piped water supply to houses greatly reduced the drudgery of women. However, in summer and in times of drought the frequency is insufficient and the drinking water needs of the households and livestock have been met from community wells. At these times, women's workload increased as they walked long distances to fetch water from the community wells, which at times required a whole day. Sanitation facilities have contributed to improved health and security of women.

3.4.5 Public distribution system

In the study area, community members stated that at present they had access to the timely supply of average quality food grains (wheat and rice) through the PDS – a state food supply program. Villages located far off from the market largely depended on the PDS. In times of scarcity and crop loss, dependence on the PDS increased. The food grains provided were mainly cereals, which did not meet their nutritional needs. The PDS has also suffered from several other limitations, such as leakage, wastage due to poor storage facilities, inclusion of the better-off, corruption at different levels, high administrative costs, poor monitoring systems, lack of accountability and poor beneficiary participation (Mane, 2006; Gaidhane, 2015).

3.5. Assessment of the five capitals and vulnerability to climate and non-climate risks

The current section illustrates the vulnerability of the different social groups identified, based on the status of the five capitals and in relation to their exposure to climatic and non-climatic risks, the coping strategies, enablers and barriers. Under the livelihood capitals, some important parameters are considered in order to assess people's resilience to risks.

3.5.1 Small and marginal farmers: the vulnerability context

The emerging climate risks in the region and their subsequent impacts (ref. to section 3.2) have a profound effect on natural resources. Figure 4 provides a snapshot of the vulnerability status of small and marginal farmers belonging to different social categories. This is based on the scores given to indicators under the five capitals presented in Annexure 1. As these are agrarian communities, the local production systems are dependent on the status of the natural resource base, hence are interlinked. Changes in access, ownership and functionality of the capitals have triggered chain reactions within these systems. Impacts such as the depletion of groundwater and deterioration in the quality of CPRs due to reduced seasonal rainfall, have affected the agriculture and livestock production systems. Fodder scarcity has forced farmers to reduce their livestock holdings, resulting in a drop in animal based products. The limited availability of manure has prompted shift towards increased use of chemical fertilizers, lowering crop productivity and soil fertility. In the recent past, the two main livelihoods (i.e. agriculture and livestock rearing) have become unviable. As people lack other skills, they are forced to depend on farm and unskilled wage labour. While wage work is available, the high summer temperature and the increased incidence of vector borne diseases caused by unseasonal rainfall have reduced their work efficiency. Lowered income and rise in expenditure

have increased debts, causing a breakdown of the social capital. This is observed in the collapse of SHGs and the increased conflicts over scarce resources. Given this situation, the degree of vulnerability differs across the social groups of small and marginal farmers, as their access to the capitals is not uniform. Using indicators relevant to the main livelihoods in the study area, Annexure 1 provides a comparison between the social groups, based on the status of their livelihood capitals and the associated vulnerability to climate change.

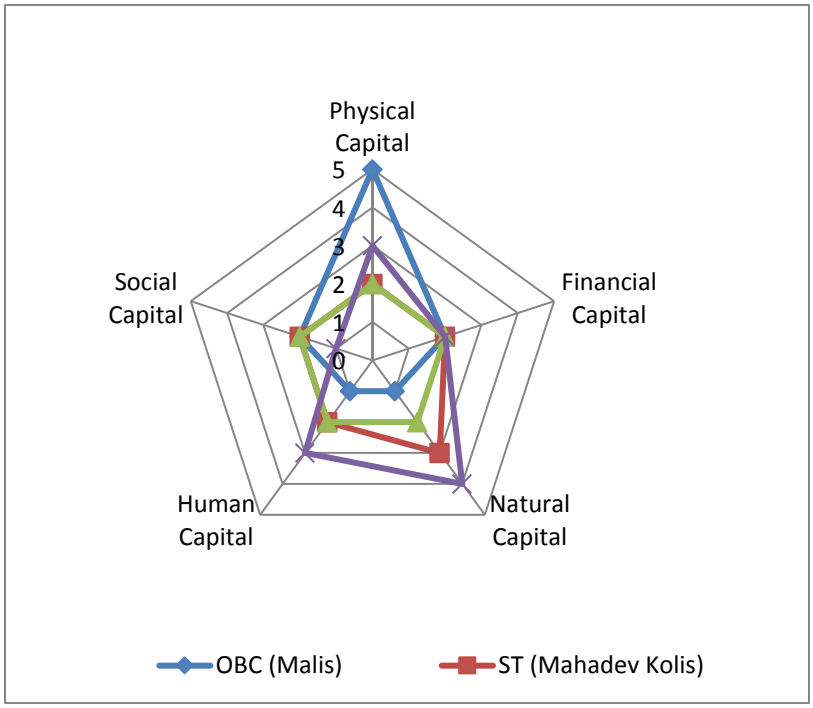

Figure 4: Vulnerability codes of small and marginal farmers

The OBC (*Mali*) farmers from *Borban* are found to be more progressive as compared to other small and marginal farmers in the study sites (Figure 4). Even though they own small parcels of land, having good access to water directly from the river Mula, they have shifted to pomegranate cultivation (refer to Box 1). They have invested heavily in productive physical capital (score 5), such as water storage tanks, dug/tubewells and drip irrigation systems. About 95% of these farmers had accessed the subsidy for pomegranate from the government in 2006; approximately 70% of the farmers own tractors and agriculture related infrastructure such as warehouses. The improved power supply has increased the area under irrigation leading to an inappropriate use of the natural capitals – water and soil health (score of 1). Their knowledge of climate compatible farming methods, the high external input agriculture practiced, the exclusive mono-cultivation (pomegranate) production system, and their lack of alternate livelihood skills, puts them at risk to climate change and raises questions about their future vulnerability and the long term sustainability of their land. The small and marginal farmers from other villages, in contrast to the OBC (*Mali*) of *Borban*, are not as resourceful (Annexure 1) in obtaining physical infrastructure and subsidies. Agriculture of the ST (*Mahadev Koli),* FC *(Rajput)* and VJNT *(Banjara)* farmers is mainly rainfed. They own few physical infrastructures such as irrigation sources, micro-irrigation, farm equipment and post-harvest

structures. Their main livelihood sources are subsistence agriculture and wage labour. Most of them rear goats and backyard poultry to supplement their household needs. However, the farmer communities of this category vary in their vulnerability to the 5 capitals. In the given context, the *Banjaras* (VJNT) appear more resilient, as they manage well under rainfed conditions having innovated on their traditional knowledge of livestock management (semi-intensive goat rearing) and rainfed farming of food and fodder crops (natural capital score of 4; human and physical capital score of 3). However, they do not maintain strong community ties (social score of 1).

While the small farmers of the *Rajput* community practice rainfed agriculture, they also cultivate high external input Bt cotton. As they have relatively more access to CPRs than the *Banjaras,* they rear small ruminants on an extensive mode. The *Rajputs* have relatively better access to credit, which may be attributed to being a forward caste group. Climate risks have made them also rely on non–farm work which is an important alternative livelihood source. Thus the above findings place the small and marginal *Rajput* farmers high on the vulnerability scale for all five capitals.

The *Mahadev Kolis* practice rainfed subsistence agriculture, with goat rearing being a secondary source of income. They largely earn from agricultural wage labour as seasonal migrants. With weather variation, seasonal migration has increased in recent years. Although there are several developmental programs, the benefits are inaccessible due to various procedural bottlenecks. Because of this, except for the natural capital (score 3, medium vulnerable), the *Mahadev Koli* community was highly vulnerable (score of 2) for all other capitals.

BOX 2

The story of the small farmers of Borban village

Located on the bank of the river Mula that flows through the Sangamner *taluka*, Borban is a village of 600 inhabitants. The majority of villagers are engaged in agriculture and more than 95% of the farmers belong to the small and marginal landholding category. Borban is an archetypal village in terms of its agro-climatic and socio-economic homogeneity, which it shares with the other villages in the Sangamner *taluka*. Yet there is something unique about Borban that makes it an anomaly.

Borban presents a case of 'market forces' that changed the cropping pattern. A group of entrepreneurial farmers, dissatisfied with the returns from traditional farming set out to explore the agricultural market for cultivating economically lucrative crops. Through word of mouth they came to know of a few farmers in other villages of the Sangamner *taluka* who had taken up the cultivation of pomegranate. After communicating and consulting with the cultivators and studying the pomegranate cultivation practices, the Borban farmers were convinced. They explored market linkages, sources of credit and other inputs.

Within a few years, these farmers excelled at pomegranate production. They developed robust market links with buyers across the country. Their produce was being sold in the cities of New Delhi, Jaipur, Pune and Sangamner in India and was also being exported from Mumbai. Having access to water throughout the year – as the village is located on the banks of the river Mula – the farmers were able to access credit from cooperative credit societies. Observing the success of the pomegranate cultivation of the initial few farmers, today approximately 90-95% of the farmers produce pomegranate. The village has reached a stage of a near monoculture!

Farmers of Borban have earned lucrative economic dividends from this crop. The gross earning of a farmer ranges from Rs 400,000 to Rs 600,000 (US$ 6,500 to US$ 10,000) per annum. This has enabled the villagers to build modern houses with toilets and educate their children in the metropolitan cities of Maharashtra (Pune and Mumbai). Some farmers have purchased fancy Sport Utility Vehicles (SUVs) too!

Even though the farmers have been successful, the high dependence on external inputs (chemical fertilizers and pesticides) and the mono-cropping of pomegranate puts the farmers at risk in terms of sustainability and climate variability.

3.5.2 Large and medium farmers: the vulnerability context

The resources available to farmers of the large and medium land holding categories in both study sites are somewhat similar, therefore both categories are assessed as one. The large landowners in Sangamner are almost exclusively from the FC (*Maratha*) community and the medium landowners are from the *Rajput* (FC) and *Banjara* (VJNT) communities in the Aurangabad site. Figure 5 gives a picture of the vulnerability status of the three social groups under large and medium farmer categories and Annexure 2 provides details of the indicator under the five capitals.

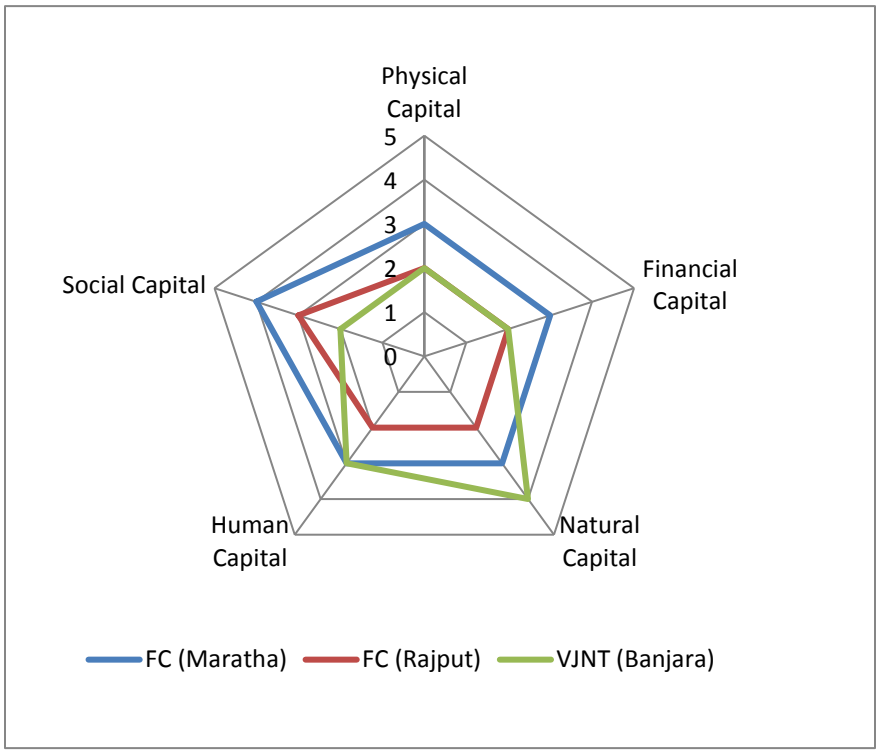

Figure 5: Vulnerability codes for large and medium farmers

These communities have better access to land and water resources as well as greater access to the markets and information. As theirs is a high external input market driven agriculture (high yielding seed varieties, chemical inputs, mechanization and groundwater extraction) with a focus predominantly on commercial crops, the climatic and non-climate risks have led them to excessively exploit the natural resources – groundwater and soil. All farmers of these communities own wells and/or bore-wells, but micro-irrigation practices are followed in Sangamner and not in the Aurangabad cluster as the water accessibility is poor. In terms of the financial capitals, the *Maratha* (FC) farmers in the Sangamner *taluka* fare better as compared to the *Rajputs* and *Banjaras*. All three social groups in this farmer category cultivate high external input commercial crops, invest in and avail of government subsidies, but the *Marathas* have easy access to subsidies and financial support because of their political connectedness and their ability to repay loans. Some of them even provide loans to others. Besides, the Sangamner farmers rear cross bred cows (focus on dairy) and cultivate

market driven vegetable crops and also grow coarse cereals for home consumption. In times of drought and weather vagaries, they fall back on such crops to meet food and fodder needs and simultaneously also use treated farmyard manure. The *Banjaras* too grow food and fodder crops besides small quantities of cotton and manage their livestock according to good traditional practices. The *Rajputs* grow mainly Bt cotton and depend on the markets for food and fodder and experience the weather stressors the most. The large and medium farmers (all communities) may have more market information and knowledge of agriculture practices for commercial and horticulture crops and dairy farming, however, they have little knowledge of climate smart and sustainable farming methods. With respect to personal assets, all farmers of this group have concrete houses and access to piped drinking water at household and community levels. Water supply for domestic use is better in the *Banjara* communities as compared to the *Rajputs.*

Cohesiveness among *Marathas* is visible in their self-organization for learning new agriculture practices, accessing subsidies as well as the active functioning of the women's SHGs long after the project completion. The *Rajputs* work together for non-monetary purposes and their political connectedness helps them access benefits, while the *Banjaras* barely meet as a community. In the Aurangabad communities, the SHGs were active during the project period when several assets were created, however they later became inactive because of the migration of some of the members in search of livelihoods, as well as the inability of others to repay the loans taken from banks.

With regard to the human capital, the *Marathas* are proactive learners, though they totally depend on commercial agriculture and dairy for livelihoods. The *Banjaras* put their good traditional knowledge to use for livestock management and food security. The *Rajputs* have poor knowledge of sustainable agriculture and livestock practices, but they have good non-farm skills. The Aurangabad communities fall back on un-skilled and skilled wage labour to supplement their income during times of stress, which is why the financial capital of both communities is low (score 2). However, the increased heat conditions and vector borne diseases due to unseasonal rain have limited their efforts to access alternate livelihood options.

BOX 3

Semi-intensive goat husbandry by the Banjaras in the Aurangabad and Paithan *talukas*

The *Banjaras* are a pastoral tribe, also referred to as the "Gypsies of India". They usually live in small settlements called "*Tandas*" – i.e. settlements outside the main village. While many have settled into agriculture over the past few decades, livestock rearing is central to their farming system.

Respondents revealed that in the past, animal husbandry was their primary occupation. Each household reared herds of up to 12- 15 cattle, 3-4 buffaloes and around 45 goats and native poultry. Livestock contributed a major share to the household income through the sale of milk, milk products, goats, poultry and eggs, while crop cultivation was for subsistence to meet household consumption needs.

Decreasing common property resources and restrictions on access to forest areas resulted in a shift towards crop cultivation as a major source of household income. Currently the households rear a pair of bullocks, around 10-15 goats and few native poultry. Frequent crop losses and few opportunities for alternate livelihoods triggered the *Banjaras* to fall back on their animal husbandry skills which has led them to rear goats in a semi-intensive mode, a departure from the traditional extensive mode.

The semi-intensive system involves reducing the grazing time to half a day and compensating for it by feeding goats with finely chaffed crop residues mainly of pigeon pea, green fodder (alfalfa) and local feed such as cotton seed cake. The *Banjara* farmers shared that health care in such a system is critical, hence measures/investments for preventive health care is built in. While the small and marginal farmers rear local non-descript goat breeds, the medium and large farmers have invested in high value breeds, foreign to the region, such as Sangamneri, Osmanabadi, Boer (breed from South Africa) and other exotic breeds.

Interaction with one such *Banjara* farmer indicated that on average, the annual expenditure for feed and health care for an average flock of 10 goats (adults and kids) is Rs. 3,000–5,000 (US$ 50-80). The earnings are approximately Rs. 25,000-30,000 (US$ 400-500) every six months. While farmers have moved to a semi-intensive system of goat rearing, they do claim that the grazing based system was far more lucrative as investment were low and incidence of disease was also low.

3.5.3 The Landless Poor: the vulnerability context

In the Aurangabad study site, the landless poor *Rajput* households are less than 10% of the population. At the time of this survey, they had migrated to nearby cities for wage work, hence were not present in the villages. Figure 6 gives the status of vulnerability of the landless *Mahadev Koli* community, the details of which are described in Annexure 3.

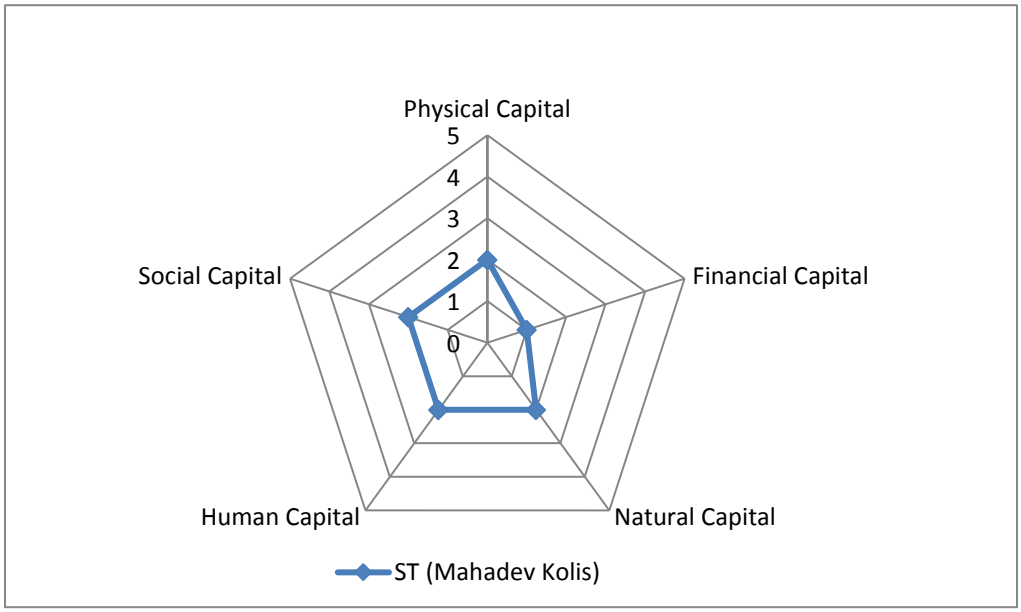

Figure 6: Vulnerability codes for the landless poor

The set of indicators determining the vulnerability to climatic and non-climatic risks are somewhat different for the landless category as compared to that of the farmer categories. For the landless poor ST (*Mahadev Koli*) community of the Sangamner area, the human and financial capitals play an important role in their welfare. The sources of income for both men and women are skilled and unskilled wage work (at dam and road construction sites or carpentry, masonry and providing services within and outside the village), as well as unskilled work in agriculture and sugarcane cutting in the nearby areas. Work in agriculture is often paid in kind: in fodder and food grains, the latter supplements of the PDS. Apart from wage work, the landless poor maintain small numbers of goats and backyard poultry. As and when required, they access loans from the large farmers. In terms of the physical capital, the landless own only *Kaccha* (earthen and of poor quality) houses that generally do not have toilets.

Although this category does not own land, their living and livelihoods are however greatly affected by climate risks. As agricultural wage labour is their main livelihood source, in times of agriculture stress this major source of income is at risk. At such times, other farming categories compete for the agriculture wage work where available. Hence, during droughts, the landless migrate to distant places and towns to take up any type of wage work available. In ill health or heat stress, members of this group continue working.

With regards to their physical capital: in times of water scarcity, while water is available in the village, they generally have to walk far from their settlement to the community wells, as compared to the other farmer categories. Their *kachha* houses are easily damaged by heavy rains and require loans to repair them. Though they own few small ruminants, drought like conditions reduce fodder availability which affects this source of income. Their resilience is low (with score of 2) for the physical, natural, human and social capitals, and very low (score of 1) for the financial capital (Annexure 3, Figure 6), making this group very vulnerable. This group has active youth groups, however, mainly in cultural activities. While women are part of SHGs, their participation is mostly passive and they are able to access loans from their groups. The frequent migration also makes the people passive members of the *gramsabha* (general body meeting of the village). While there are government schemes and subsidies available for the M*ahadev Koli* landless poor (being tribals), their social status and various bottlenecks prevent them from accessing these.

4. Conclusions

The major climate risks in the region were unseasonal rainfall, increased dry spells, high intensity rainfall, delayed onset of monsoon, warmer winters and very high summer temperatures. The non-climatic risks included price fluctuations, lack of post-harvest infrastructure, loss of common property resources, depleting groundwater levels and increasing land fragmentation. There are also several regional governmental and non-government programs that affect the livelihood capitals of the communities. Initiatives for the provision of credit facilities, soil and water conservation measures, government subsidies for agricultural inputs, welfare measures for SC/ST categories of communities, provision of drinking water and sanitation facilities and PDS all serve as enablers that enhance the livelihood and food security of the rural communities. But there are also certain barriers that render the services inaccessible to weaker sections of the society. In the context of vulnerability, farmers from all categories including the landless poor demonstrate a high sensitivity to both climate and non-climatic risks. However, there are differential vulnerabilities across the landowning categories, as well as among the different social groups within a farmer category.

In general, access to water resources made a difference in the livelihoods of farmers across different categories. Irrespective of the category of farmers (small, medium and large), investment in irrigation infrastructure improved their income and their ability to take up commercial crops e.g. pomegranate in Borban (by the *Malis*) or cotton farming in Aurangabad (by the *Rajputs*), or shift to commercial agriculture and dairy production in Sangamner (*Marathas*). As farming shifted to high external input and water intensive systems in the region, it shows a higher vulnerability to the current and future climate risks particularly in a semi-arid region. However, the findings indicate that access to /investments in irrigation do not necessarily reduce vulnerability, or that rainfed farming increases vulnerability. This was clearly seen in the cases of the small and marginal *Mali* community farmers of Borban whose lands and crops are at a higher risk from future climate impacts, while the *Banjaras* (from all farmer categories) successfully managed agriculture and semi-intensive livestock rearing in rainfed conditions. All the other small and marginal farmers who depended on rainfed agriculture were identified as highly vulnerable.

Important lacunae are identified, which if addressed will enhance the resilience of all social groups. Some of these are knowledge and access to climate smart/compatible agriculture technologies, promotion of adaptive sustainable agriculture practices, good water management practices, post-harvest infrastructure and facilities, access to crop insurance and increased outreach of climate information services.

Caste and social standing play a major role in access to resources and subsidies across all farmer categories. Although subsidies and government programs exist for the ST communities (*Mahadev Koli)* and for landless poor, for various reasons these government programmes are still inaccessible to them. Much effort and capacity building is still required to help the small and marginal farmers, particularly the *Mahadev Koli* community who are the most vulnerable, to become resilient.

The study shows that women were affected differently by the climate and non-climatic risks and have perspectives that can contribute to adaptation. Addressing water for domestic needs and sanitation is important for women of all categories and communities and is considered a 'major relief'. The burden and workload of women has increased due to the intensive production systems adopted such

as: vegetable cultivation, horticulture, crossbred cow milk production, and semi-intensive goat husbandry. The women's SHGs that were active during the project period initiated by the NGO have also been affected by climate variability. Migration in search of wage labour (Aurangabad groups) is a major factor for their discontinuity, while in the more organized communities who have assured agriculture income, the SHGs flourish.

There are differences in types of skills and inherent knowledge among the different social groups that may be attributed to respective cultures. In general, the most vulnerable and socially backward communities the *Mahadev Kolis* rely on unskilled wage labour (farm and non-farm) and on goat rearing. However, the *Banjaras* handle livestock and mixed farming agriculture well, and the *Rajputs* do well in non-farm works. The *Maratha* and *Mali* communities are progressive farmers. When they are exposed to climate adaptive sustainable agriculture practices, they are likely to be leaders for their region. A deeper study of the farming practices (agriculture and livestock rearing) of the *Banjara* community would help to understand their system and how they adapt to both climatic and non-climatic risks. Resilience of communities and their natural resource base can be enhanced by capitalizing on the strengths of the various communities to address these climatic and non-climate risks. Vulnerability assessments need to be conducted at smaller scales rather than treating districts as a whole, as climate risks vary within the clusters – as observed in the study sites. This advocates the need for a cluster-based, holistic and participatory approach for assessing vulnerability to climatic and non-climatic risks.

The experiences from this study underscore the need to adopt a mixed methodological approach that blends community engagement with analytical and academic research to develop appropriate adaptation policies. Lack of community participation runs the risk of missing people's perceptions, their adaptive strategies and climate smart responses and unwittingly promoting the spread of maladaptive practices. Such an approach could complement the survey based research by capturing the linkages between local production systems and the drivers (enablers and barriers) that influence adaptive capacity.

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6. Annexures

Annexure 1: Assessment of selected parameters under the respective capitals for the small and marginal farmer category

District	Ahmednagar		Aurangabad	
Community / Capital wise Indicators	**OBC (*Mali*)**	**ST (*Mahadev Koli*)**	**FC (Rajput)**	**VJNT (Banjara)**
Physical capital				
Water resource (tube wells, dug wells, pump sets) and status	Yes (3); water perennially available	No (2); major part of agriculture rainfed	No (1); Number of bore wells and dug well exist; however, majority are defunct.	No (3); Preference for well deepening; water seasonally available
Micro-irrigation facilities and use	Yes (5)	No (1)	No (1); water insufficient to support such technology	No (1); water insufficient to support such technology
Post-harvest storage facilities	Yes (5)	No (1)	No (1)	No (1)
Transportation facilities: vehicles, tractors	Yes (5), almost all farmers own vehicles	No (2) Depend on public transport; frequency is low	No (2); use public transport	No (3); use public transport and bullock carts
Access to drinking water	Yes (5); regular piped water supplied at household level	Yes (3); piped supply was limited to few hours / day; however, they had access to community wells	Yes (2); at household level; non- functional due to water scarcity	Yes (3); functional and at household level; however, water was received once in 3-4 days (at the time of data collection)
Houses with toilets in use	Yes (5)	No (1)	Yes (4)	Yes (4)
Financial capital				
Access to financial resources / formal and informal credit	Yes (3); have repayment capability; but risky when crop fails	No (3); currently appear comfortable with subsistence farming	Yes (3); for agriculture loans obtained from smaller banks; access loans for other needs from money lenders	Yes (2); are not able to access it as much as the *Rajputs*

High external input agriculture	Yes (1); totally dependent on external inputs	No (3); Practice subsistence farming	Yes (2); mainly BT cotton grown; but grow some food crops	No (4); Emphasis on food cum fodder crops
Access to subsidies	Yes (4); high usage	No (1); low access of subsidies	Yes (3); high usage	Yes (3); low usage because of choice of crops
Crop insurance	No (1)	No (1)	No (1)	No (1)
Proxy indicators for productive and non-productive assets	Yes (4), They own higher number of productive and non-productive assets which enhances their risk taking capacities.	No (1), They own minimal assets	No (1), They own minimal assets	Yes (2),
Natural capital				
Type of crops grown (food / commercial crops)	Yes (2); only pomegranate grown for commercial purpose	No (3); Only subsistence crops grown	No (2); Emphasis on cotton	No (4); Integrated agri-livestock system
Large ruminants (cows, bullocks)	No (1); Do not own cattle	No (1); Do not own cattle	No (1); significant reduction in livestock holdings	Yes (3); Retain bullocks
Small ruminants SR (goats)	No (1); Do not own small ruminants	Yes (3); but few	Yes (3); Extensive SR rearing	Yes (4); Semi-intensive SR rearing
Backyard poultry	No (1)	Yes (3)	No (3); Stopped 2-3 years earlier for religious purposes	Yes (4)
Fodder resources – (CPRs /crop residues/ purchase from market)	No (1); fodder not required as do not own livestock	Yes (2); Crop residues	Yes (2); Dependent on CPRs and market	Yes (4); Dependent on crop residue, CPR and specialized feeds
Human capital				
Knowledge of sustainable/climate smart cropping practices	No (1)	Yes (3); Rely on traditional practices	No (1); have no new knowledge on sustainable crop practices or traditional practices	Yes (3); have modified their traditional practices

Access to climate information services	No (1)	No (1)	No (1)	No (1)
Livestock management practices	No (1); No livestock – a missing component	No (1)	No (1)	Yes (4), semi intensive; built on their traditional knowledge
Skills for alternate livelihoods	No (1) No alternative skills	Yes (4); skilled and unskilled	Yes (4); skilled and unskilled	Yes (3); Only unskilled
Willingness to learn and adopt new practice	Yes (4)	No (1)	Yes (2)	Yes (4)
Literacy	Yes (4)	Yes (4)	Yes (4)	Yes (4)
Social capital				
Women SHGs	Yes (4); functional and active	Yes (3); but have limited say; however, they have access to credit	Yes (3); Partially defunct; non-monetary activities being conducted	Yes (2); Defunct due to lack of other livelihood options & non-repayment of loans to banks
Youth groups	No (1)	Yes (3); active participation, but in non-productive activities	Not applicable – younger generation migrate for education to nearby towns	Not applicable – younger generation migrate to nearby towns for wage labour
Farmer groups	No (1)	No (1)	No (1)	No (1)
Political connectedness	No (1)	No (1)	No (1)	No (1)

Note: "Yes" indicates presence of the particular capital and "No" refers to absence. Figures in parenthesis indicate resilience scores based on presence/access/functionality as appropriate; 1= No resilience, indicates "very high" vulnerability; 2=Very low resilience, indicates "high" vulnerability; 3=Low resilience, indicates "medium" vulnerability; 4=Medium resilience, indicates "low" vulnerability; 5=High resilience, indicates "very low" vulnerability.

Annexure 2: Assessment of selected parameters under the respective capitals for the large and medium farmers

District	Ahmednagar	Aurangabad	
Community / Capital wise Indicators	**FC (*Maratha*)**	**FC (Rajput)**	**VJNT (Banjara)**
Physical capital			
Water resources (tube-wells, dug wells, pump sets) and status	Yes (3); majority of wells and borewells function	No (1); most of the wells have little water and for few months a year: some borewells failed	Yes (3); majority of dug wells function; however water levels are low; some borewells failed
Micro-irrigation facilities and use	Yes (3); for onions and tomatoes; however flood irrigation is used for other food crops	No (1) Water insufficient to support micro-irrigation	No (1) water levels are low and available for short periods only, hence do not support irrigation;
Post-harvest storage	No (1)	No (1)	No (1)
Transportation facilities: vehicles, tractors	Yes (5); All farmers own vehicles	Yes (4); Possess own vehicles and tractors	Yes (3); Rely on public transport and own bullock carts
Access to drinking water	Yes (3); piped water supply at community level) is limited to few hours, however people avail of water from wells located on their farms	Yes (2); piped at household level, but non- functional due to water scarcity; farmers access water from wells that are near check dams; village also received water in tankers this drought year (2016)	Yes (3); piped water functional at household level; however water was received once in 3-4 days during this drought year
Houses with toilets in use	Yes (4)	Yes (4)	Yes (4)
Financial capital			
Access to financial resources / formal and informal credit	Yes (4); from banks and credit societies; have good repayment capability	Yes (3); for agriculture loans obtained through national banks; They access loans from money lenders for social needs	Yes (2); have access, but less than the *Rajputs*
High external input agriculture	Yes (2); external input costs are high since	Yes (2); mainly BT cotton grown; high	Yes (3); Grow cotton more than

	they focus on cash crops like onion and tomatoes; some farm yard manure only for food crops grown for home consumption	investments made; do not grow food crops	the small and marginal farmers; they grow much smaller amounts of food and fodder crops.
Access to subsidies	Yes (3); for fertilizer and seeds	Yes (2); fertilizer subsidies only; usage higher than the Banjaras	Yes (3); fertilizer subsidies only; subsidy usage low because of the choice of crops
Crop insurance	No (1)	No (1)	No (1)
Proxy indicators for productive and non-productive assets	Yes (4), They own higher number of assets	Yes (2)	Yes (3)
Natural capital			
Type of crops grown (food / commercial crops)	Yes (4); focus on commercial crops – onion, tomato and pomegranate; but food crops are grown too	Yes (1); mainly commercial BT cotton	Yes (3); Some BT cotton, but crops for food security is ensured
Large ruminant animals (cows, bullocks)	Yes (3); more crossbreds by some large farmers; others have retained to indigenous breeds	No (1); significantly reduced livestock holdings	Yes (4); have milch cattle and also own bullocks
Small ruminants (goats)	No (1); do not own small ruminants	Yes (3); extensive type of SR rearing; non-descript breeds reared	Yes (4); semi-intensive (semi-stall fed)
Fodder resources (crop residues and purchase from market)	Yes (3); purchase crop residues from market	Yes (3); purchase crop residues; partial grazing also practiced	Yes (4); crop residue from own crops; purchase only special feeds
Human capital			
Knowledge about sustainable / climate smart cropping practices	Yes (3); some good practices followed, but only for food crops (home consumption)	Yes (1); not practiced	Yes (3); partially practiced, mostly rely on traditional knowledge
Access to climate information services	No (1)	No (1)	No (1)
Progressive livestock management practices	Yes (3); lack of man power has reduced the livestock holding at HH level	No (2)	Yes (4); semi-intensive goat husbandry
Wage work and alternate livelihood sources	No (3); by choice this community does not take up wage work	Yes (4); skilled and unskilled	Yes (3); only unskilled

Willingness to learn and adopt new practices	Yes (4)	Yes (2)	Yes (4)
Literacy	Yes (3)	Yes (4)	Yes (4)
Social capital			
Women SHGs	Yes (4); for monetary and non- monetary activities	Yes (3); partially defunct, non-monetary activities being conducted	Yes (2); defunct due to lack of other livelihood options and non-repayment of loans to banks
Youth groups	Yes (5); active participation	NA; not applicable – younger generation migrate for education and skilled work to nearby towns	NA; not applicable – younger generation migrate to nearby towns
Political connectedness	Yes (4)	Yes, (3)	Yes (2)

Note: "Yes" indicates presence of the particular capital and "No" refers to absence. Figures in parenthesis indicate resilience scores based on presence/access/functionality as appropriate; 1= No resilience, indicates "very high" vulnerability; 2=Very low resilience, indicates "high" vulnerability; 3=Low resilience, indicates "medium" vulnerability; 4=Medium resilience, indicates "low" vulnerability; 5=High resilience, indicates "very low" vulnerability.

Annexure 3: Assessment of selected parameters under the respective capitals for the landless poor

Capital wise Indicators	ST (*Mahadev Koli*)
Physical capital	
Access to transportation	No (2); depend on poor public transport
Housing	Yes (2) ,*Kachha* own houses
Access to drinking water	Yes (3); piped supply is limited to few hours / day; however, they have access to community wells
Houses with toilets in use	No (1)
Assets for livelihoods	No (2) very limited
Financial capital	
Source of livelihood- assured	Very few (1), own petty shops in the village
Source of livelihood-wage	Yes (3) wage work on contractual basis
Access to credit-Formal	No (1)
Access to credit- Informal	Yes (1) take high interest rates loans from large farmers
Access to subsidies	No (1)
Access to government schemes and programmes	No (1)
Natural capital	
Small ruminants (goats)	Yes (3); very few per household
Fodder resources	No (1), depend only on CPRs and access is limited
Forest	Very limited (2), they depend on forest only for fuel wood
Human capital	
Knowledge about sustainable cropping practices	Yes (3), as they work on farms owned by large land owners, they are acquainted with the newer agriculture practices
Progressive livestock management practices	No (1)
Skills for livelihood	Yes (3) some have non-farm skills masons, carpenters and others
Literacy	Yes (2)
Social capital	
Women SHGs	Yes (3); are passive; however have access to credit
Youth groups	Yes (3), very active in organizing cultural events
Political connectedness	No (1)